5-28-2020

Open Design Communities: An Exploration of Key Factors Influencing Intention to Contribute 3D Printable Designs

Siddharth Baswani
sbaswani@iastate.edu

Joey George

Anthony Townsend

Open Design Communities: An Exploration of Key Factors Influencing Intention to Contribute 3D Printable Designs

Siddharth Baswani
Iowa State University
sbaswani@iastate.edu

Joey F. George
Iowa State University
jfgeorge@iastate.edu

Anthony M. Townsend
Iowa State University
amt@iastate.edu

ABSTRACT

Consumer 3D printing can enrich our lives in many ways if it spreads beyond its current user base and emerges as a mainstream consumer technology that allows us to create (customized) products right in our homes. In this paper, we highlight the importance of open design communities (ODCs) such as Thingiverse and explore factors that may influence individuals' intentions to contribute their 3D printable designs to such communities. Drawing mostly from the existing knowledge management (KM) literature in the information systems (IS) field and focusing on Thingiverse as an exemplar, we present a conceptual model and testable hypotheses. Data for this study will be collected via an online survey of Thingiverse members. Our findings would not only extend the KM literature in IS into an important non-work related setting and pave the way for future theorizing in this context, but also provide important insights to ODC managers.

Keywords

Consumer 3D printing, contribution intention, knowledge management, open design community, social capital.

INTRODUCTION

For individuals, consumer 3D printing represents an accessible and personal mode of fabrication that might someday become an integral part of their lives (Schwab, 2016). At present however, consumer owned 3D printers remain niche (Jordan, 2019; Office of Inspector General, 2015). In this, the complexity of computer-aided design (CAD) software, which remains too complicated for the casual consumer to pick-up, is a contributing factor (Jordan, 2019; Office of Inspector General, 2015).

Here, it is important to consider the role that online communities (OCs) (Faraj, Jarvenpaa and Majchrzak, 2011) dedicated to the sharing of 3D printable designs, referred to as open design communities (ODCs) (Kyriakou, Nickerson, and Sabnis, 2017) in this paper, can play. For example, Thingiverse, which is the largest ODC in the world (Flath, Friesike, Wirth and Thiesse, 2017; Kyriakou et al., 2017; Stanko, 2016) provides its members access to over 1.6 million (as of February 2020) designs, many of which are customizers that can be remixed without knowledge of CAD software (Flath et al., 2017).

The existing IS literature on 3D printing has examined the ways in which knowledge, (in the form of 3D printable designs) shared on Thingiverse, can been reused via remixing to create new knowledge (Flath et al., 2017; Kyriakou et al., 2017; Stanko, 2016). Although this literature provides insights into remixing (or customization) of 3D printable designs on Thingiverse, it leaves the question of design contribution unexamined. This is important because such contributions to ODCs, similar to other OCs, are essential for realizing their value for their members (and sponsoring organizations) (Ma and Agarwal, 2007).

Keeping the above in mind, we would like to to explore key factors that are likely to influence Thingiverse members' intentions to contribute their 3D printable designs to this exemplary ODC. In doing so, we seek to answer the following research question:

RQ: What are the key factors that are likely to influence individuals' intentions to contribute their 3D printable designs to ODCs?

Following this introduction, we present some background information in the next section. Our conceptual model and hypotheses are presented in the following section. This is followed by the proposed research methodology and conclusion sections.

BACKGROUND

When exploring factors that are likely to influence the 3D printable design contribution intentions of Thingiverse members, it is useful to turn to the IS literature on KM. Although this literature focuses on work related settings, the insights it offers into individuals' intentions and use of knowledge management systems (KMS) are relevant in an ODCs context.

Among the various models provided by this literature, the social capital model by Wasko and Faraj (2005) seems to be the most appropriate for the purposes of this study. The Wasko and Faraj (2005) model includes individual motivations and three types of social capital, namely structural, cognitive, and relational capital, as predictors of knowledge contribution in electronic networks of practice, which are similar to OCs (Faraj et al., 2011). Wasko and Faraj (2005) had adapted the concept of social capital, which is usually considered at the group level (Lin, 2001), to an individual level and had identified relationships that exist "between individuals and the collective as a whole" (Wasko and Faraj, 2005, p.39) to be a source of social capital in electronic networks of practice. This social capital, in turn, influences individuals' behavior towards others in in the network (Wasko and Faraj, 2005). We believe that such relationships would also exist in Thingiverse.

Based on the above discussion, we adopted the Wasko and Faraj (2005) model as our initial theoretical framework and modified it to arrive at our conceptual model, which is presented next.

CONCEPTUAL MODEL AND HYPOTHESES

We started by removing all non-significant predictors from the Wasko and Faraj (2005) model except commitment. We also removed structural capital because our study's design does not involve collection of the (secondary) data that would be required for measuring this construct. Next, we replaced individual motivations with extrinsic benefits and intrinsic benefits, similar to Kankanhalli, Tan and Wei (2005), who had included several individual level cost and benefit factors in their model. This allowed us to tap into constructs such as financial reward, which is similar to organizational reward (Kankanhalli et al., 2005), and knowledge self-efficacy (Kankanhalli et al., 2005) that would provide a richer understanding of individuals' motivations in this context than reputation by itself. These changes led to our conceptual model (shown in Figure 1).

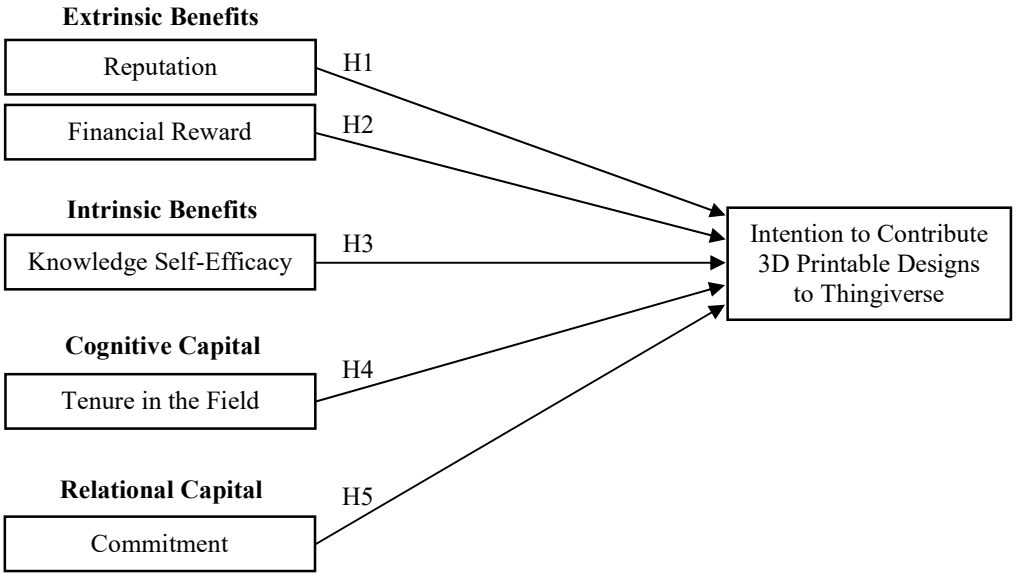

Figure 1. Conceptual Model for 3D Printable Design Contribution Intention

Whereas Kankanhalli et al. (2005) had found that image (or reputation) was not a significant predictor of electronic knowledge repository (EKR) usage, Wasko and Faraj (2005) had found reputation to be a strong positive predictor of

knowledge contribution. Here, we are inclined to believe that a desire to enhance one's reputation among other members is likely to be positively related to one's intentions to contribute 3D printable designs. Thus we posit:

H1: Reputation is positively associated with the intention to contribute 3D printable designs to Thingiverse.

Designers on Thingiverse can benefit financially from their designs by receiving money in the form of tips from in-app purchases and from other members ("Thingiverse Developer Program Invites Community to Shape the Future of 3D Printing," 2016). Bock, Zmud, Kim and Lee (2005) had found that anticipated extrinsic rewards have a negative effect on attitude toward knowledge sharing. Kankanhalli et al. (2005) however, found organizational reward to be a significant positive predictor of EKR usage. Although the amounts earned by designers in this way would probably not be considerable, small rewards can reinforce desirable behaviors, in this case design contribution (Eisenberger and Cameron, 1996). This leads to our second hypothesis:

H2: Financial reward is positively associated with the intention to contribute 3D printable designs to Thingiverse.

Kankanhalli et al. (2005) had found knowledge self-efficacy to be a significant positive predictor of EKR usage. Similarly, in an ODCs context, individuals' perceptions of their ability to provide knowledge in the form of 3D printable designs are likely to positively influence their intentions to contribute these designs. This brings us to our third hypothesis:

H3: Knowledge self-efficacy is positively associated with the intention to contribute 3D printable designs to Thingiverse.

Wasko and Faraj (2005) had found tenure in the field to be a significant positive predictor of knowledge contribution. Similarly, we expect the duration of time that an individual has been a member of Thingiverse to be positively associated with their intentions to contribute 3D printable designs. Thus we posit:

H4: Tenure in the field is positively associated with the intention to contribute 3D printable designs to Thingiverse.

Although Wasko and Faraj (2005) had not found commitment to be significant in their study, we feel that it may be important in this context. Consumer 3D printing adoption requires considerable knowledge and effort on an individual's part (Jordan, 2019). Further, an individual's commitment to consumer 3D printing may influence their perception of Thingiverse. Here, we expect individuals' commitment to Thingiverse to be positively associated with their intentions to contribute 3D printable designs and present our fifth hypothesis:

H5: Commitment is positively associated with the intention to contribute 3D printable designs to Thingiverse.

PROPOSED RESEARCH METHODOLOGY

In this study we will follow a survey methodology to collect quantitative data that will be analyzed using the structural equation modelling (SEM) package Mplus. The population of interest would be all Thingiverse members living in the United States and Canada, many of which should be accessible via an online survey. Our survey instrument will consist of scales adapted from the existing literature. The face validity of our survey instrument will be evaluated by a group of qualified researchers. This combined with the items being derived from the existing literature should help establish its content validity (Straub, Boudreau and Gefen, 2004). Next, the survey will be pilot tested with a group of University students who are Thingiverse members before it is administered to a Qualtrics panel of Thingiverse members for actual data collection.

CONCLUSION

Consumer 3D printing can enrich our lives in many ways but remains niche. In this paper, we note the role that can be played by ODCs in facilitating the diffusion of consumer 3D printing. Using Thingiverse as an exemplar, we seek to explore key factors that are likely to influence its members' intentions to contribute their 3D printable designs to this ODC community. With this objective in mind, we present a conceptual model and testable hypotheses.

The findings from this study would not only extend the existing KM literature in the IS field into an important and emerging non-work related setting, but also assist future theorizing in an ODC context. ODC managers would also be better equipped to sustain member contributions.

REFERENCES

1. Bock, G. W., Zmud, R. W., Kim, Y. G., and Lee, J. N. (2005) Behavioral intention formation in knowledge sharing: Examining the roles of extrinsic motivators, social-psychological forces, and organizational climate, *MIS Quarterly*, 29, 1, 87–111.
2. Eisenberger, R., and Cameron, J. (1996) Detrimental effects of reward, *American Psychologist*, 51, 11, 1153–1166.

3. Faraj, S., Jarvenpaa, S. L., and Majchrzak, A. (2011) Knowledge collaboration in online communities, *Organization Science*, 22, 5, 1224–1239.
4. Flath, C. M., Friesike, S., Wirth, M., and Thiesse, F. (2017) Copy, transform, combine: Exploring the remix as a form of innovation, *Journal of Information Technology*, 32, 4, 306–325.
5. Jordan, J. (2019) 3D printing, MIT Press, Cambridge, MA.
6. Kankanhalli, A., Tan, B. C. Y., and Wei, K. K. (2005) Contributing knowledge to electronic knowledge repositories: An empirical investigation, *MIS Quarterly*, 29, 1, 113–143.
7. Kyriakou, H., Nickerson, J. V., and Sabnis, G. (2017) Knowledge reuse for customization: Metamodels in an open design community for 3D printing, *MIS Quarterly*, 41, 1, 315–332.
8. Lin, N. (2001) Social capital: A theory of social structure and action, Cambridge University Press, Cambridge, UK.
9. Ma, M., and Agarwal, R. (2007) Through a glass darkly: Information Technology design, identity verification, and knowledge contribution in online communities, *Information Systems Research*, 18, 1, 42–67.
10. Office of Inspector General. (2015) An update on 3D printing and the postal service, Office of Inspector General, United States Postal Service, October 7. (https://www.uspsoig.gov/document/update-3d-printing-and-postal-service).
11. Schwab, K. (2016) The fourth industrial revolution, Crown Business, New York, NY.
12. Stanko, M. A. (2016) Toward a theory of remixing in online innovation communities, *Information Systems Research*, 27, 4, 773–791.
13. Straub, D., Boudreau, M. C., and Gefen, D. (2004) Validation guidelines for IS positivist research, *Communications of the Association for Information Systems*, 13, 1, 380–427.
14. Thingiverse developer program invites community to shape the future of 3D printing. (2016) MakerBot, February 8. (https://www.makerbot.com/stories/news/thingiverse-developer-program/, accessed February 13, 2020).
15. Wasko, M. M., and Faraj, S. (2005). Why should I share? Examining social capital and knowledge contribution in electronic networks of practice, *MIS Quarterly*, 29, 1, 35–57.